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Claims

1. A loudspeaker comprising:  
a support;  
5 a diaphragm mounted on the support; and  
a piezoelectric actuator arranged to provide, on activation, relative movement between two ends of the actuator, wherein each of said ends of the actuator is coupled to the diaphragm to vibrate the diaphragm on activation of the actuator.
- 10 2. A loudspeaker according to claim 1, wherein the diaphragm is mounted to the support with a portion of the diaphragm coupled to one end of the actuator being fixed relative to the support.
3. A loudspeaker according to claim 2, wherein the one end of the actuator is  
15 coupled to a portion of the diaphragm at the edge of the diaphragm.
4. A loudspeaker according to claim 2 or 3, wherein the diaphragm has an aperture separating portions of the diaphragm coupled to the respective ends of the actuator.
- 20 5. A loudspeaker according to any one of claims 2 to 4, further comprising a seal member between the diaphragm and the support extending around the periphery of a portion of the diaphragm, wherein the one end of the actuator is coupled to a portion of the diaphragm outside the seal member and the opposite end of the actuator is coupled to a portion of the diaphragm adjacent or inside the seal member.
- 25 6. A loudspeaker according to any one of claims 2 to 5, wherein the actuator is longer in transverse extent than in extent between the two ends.
7. A loudspeaker according to any one of claims 2 to 6, further comprising at least  
30 one stop member coupled to the diaphragm adjacent said one end of the actuator and

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extending to a position adjacent said opposite end of the actuator for limiting the movement of the portion of the diaphragm coupled to the opposite end of the actuator.

8. A loudspeaker according to any one of claims 2 to 7, wherein the portion of the diaphragm coupled to one end of the actuator is fixed relative to the support by being coupled directly to the support.

9. A loudspeaker according to any one of claims 2 to 7, further comprising a rigid bridge element coupled to the one end of the actuator and also coupled to a further portion of the diaphragm separated from the actuator, the portion of the diaphragm coupled to one end of the actuator being fixed relative to the support by the further portion of the diaphragm being coupled to the support.

10. A loudspeaker according to any one of the preceding claims, wherein the actuator extends between the two ends in a curve.

11. A loudspeaker according to claim 10, wherein said curve is a sector of a circle.

12. A loudspeaker according to claim 10 or 11, wherein the opposite end of the actuator has an end surface facing the diaphragm.

13. A loudspeaker according to claim 12, wherein said opposite end of the actuator is coupled indirectly to the diaphragm by a spacer.

14. A loudspeaker according to any one of claims 10 to 13, wherein one end of the actuator is coupled directly to the diaphragm by a side surface of the actuator, the actuator extending from said one end in a loop over said one end.

15. A loudspeaker according to any one of claims 1 to 9, wherein the actuator is straight.

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16. A loudspeaker according to any one of the preceding claims, wherein the actuator has a bender construction.

17. A loudspeaker according to any one of the preceding claims, wherein the actuator  
5 comprises ceramic piezoelectric material.

18. A loudspeaker according to any one of the preceding claims, wherein the support is a portion of a housing of an electronic device.

10 19. A loudspeaker assembly comprising:  
a diaphragm; and  
a piezoelectric actuator arranged to provide, on activation, relative movement  
between two ends of the actuator, each of said ends being coupled to the diaphragm to  
vibrate the diaphragm on activation of the actuator.

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20. A loudspeaker according to claim 19, wherein the one end of the actuator is coupled to a portion of the diaphragm at the edge of the diaphragm.

21. A loudspeaker according to claim 19 or 20, wherein the diaphragm has an  
20 aperture separating portions of the diaphragm coupled to the respective ends of the actuator.

22. A loudspeaker according to any one of claims 19 to 21, further comprising a seal  
member between the diaphragm and the support extending around the periphery of a  
25 portion of the diaphragm, wherein the one end of the actuator is coupled to a portion of the diaphragm outside the seal member and the opposite end of the actuator is coupled to a portion of the diaphragm adjacent or inside the seal member.

23. A loudspeaker according to any one of claims 19 to 22, wherein the actuator is  
30 longer in transverse extent than in extent between the two ends.

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24. A loudspeaker according to any one of claims 19 to 23, further comprising at least one stop member coupled to the diaphragm adjacent said one end of the actuator and extending to a position adjacent said opposite end of the actuator for limiting the movement of the portion of the diaphragm coupled to the opposite end of the actuator.

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25. A loudspeaker according to any one of claims 19 to 24, further comprising a rigid bridge element coupled to the one end of the actuator and also coupled to a further portion of the diaphragm separated from the actuator.

10 26. A loudspeaker according to any one of claims 19 to 25, wherein the actuator extends between the two ends in a curve.

27. A loudspeaker according to claim 26, wherein said curve is a sector of a circle.

15 28. A loudspeaker according to claim 26 or 27, wherein the opposite end of the actuator has an end surface facing the diaphragm.

29. A loudspeaker according to claim 28, wherein said opposite end of the actuator is coupled indirectly to the diaphragm by a spacer.

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30. A loudspeaker according to any one of claims 19 to 29, wherein one end of the actuator is coupled directly to the diaphragm by a side surface of the actuator, the actuator extending from said one end in a loop over said one end.

25 31. A loudspeaker according to any one of claims 19 to 30, wherein the actuator is straight.

32. A loudspeaker according to any one of claims 19 to 31, wherein the actuator has a bender construction.

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33. A loudspeaker according to any one of claims 19 to 32, wherein the actuator comprises ceramic piezoelectric material.